SUPPLEMENT NO. 1 TO LICENSEE EVENT REPORT 79-15

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I. INTRODUCTION

In LER 79-15, dated November 4, 1979, it was reported that evaluations of all safety-related piping supports and restraints anchored in single wythe masonry walls and in mortared double wythe masonry walls in the Trojan Plant ("Plant") were in process. It was also stated that a determination would be made as to the adequacy of safety related piping attached to other types of structures. The purpose of this Supplement No. 1 to LER 79-15 is to provide a status report as well as additional information and criteria relevant to these evaluations.

The problem identified in LER 79-15 has prompted an evaluation of the process for civil/structural review of the pipe support reaction data from vendor detail designs. A review of the design process has assured us that procedures were in place during the design of the Plant that provided for coordinated review of the designs by all disciplines; however, at that time documentation of such coordinated review was not required. Although a recent review of design documentation has provided evidence that such pipe support reaction data were communicated to the civil/structural reviewers, objective evidence of their review is incomplete in that, for most structures, only their comments related to required changes were noted on the support design details. Therefore, the program described herein was initiated to provide further documented assurance that pipe support reaction data have been given adequate consideration by civil/structural reviewers.

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II. MASONRY WALLS

The field survey and evaluations, as described in Attachment 2 of LER 79-15, of all single wythe and double wythe mortared masonry walls in the Trojan Plant which support safety-related[1] piping supports have been completed.

In the evaluations of these walls, the loads considered were in accordance with the load combinations described in the Trojan PSAR and included loads on the wall from all safety and non-safety related piping, equipment, and cable trays and from the wall's own inertial loads. The Trojan FSAR Sections 3.8.1.3.2 and 3.8.1.3.3 stipulate that the Category 1 concrete structures be designed considering the following loading combinations[2]:

During Normal Operation

$U = 1.5\ D + 1.8\ L$

$U = 1.25\ (D + L + H_o + E) + 1.0\ T_o$

$U = 1.25\ (D + L + H_o + W) + 1.0\ T_o$

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1 "Safety-related" refers to piping to be seismically qualified as identified in 10 CFR 50, Appendix B, and further identified in Regulatory Guides 1.26, Revision 3, and 1.29, Revision 3.

2 FSAR Section 3.8.1.3.2 includes the following load combination for "structural elements carrying mainly earthquake forces, such as equipment supports":

$U = 1.0\ D + 1.0L + 1.8E + 1.0\ T_o + 1.25\ H_o$

The inapplicability of such load combination to the subject walls will be discussed in a subsequent supplement to LER 79-15.

$$U = 0.9\ D + 1.25\ (H_o + E) + 1.0\ T_o$$
$$U = 0.9\ D + 1.25\ (H_o + W) + 1.0\ T_o$$

For shear walls the following apply:

$$U = 1.4\ (D + L + E) + 1.0\ T_o + 1.25\ H_o$$
$$U = 0.9\ D + 1.25\ E + 1.0\ T_o + 1.25\ H_o$$

During Accident and Safe Shutdown Earthquake

$$U = 1.05\ D + 1.05\ L + 1.25\ E + 1.0\ T_A + 1.0\ H_A + 1.0\ R$$
$$U = 0.95\ D + 1.25\ E + 1.0\ T_A + 1.0\ H_A + 1.0\ R$$
$$U = 1.0\ D + 1.0\ L + 1.0\ E' + 1.0\ T_o + 1.25\ H_o + 1.0\ R$$
$$U = 1.0\ D + 1.0\ L + 1.0\ E' + 1.0\ T_A + 1.0\ H_A + 1.0\ R$$
$$U = 1.0\ D + 1.0\ L + 1.0\ A + 1.0\ T_o + 1.25\ H_o$$

The factor T_o is applicable only in cases where differential wall temperatures sufficient to create significant internal stresses are possible (e.g. walls separating high temperature areas from the outdoors). Evaluation of interior walls need not consider such temperature gradients because the heating, ventilation, and air conditioning systems are designed to keep inside areas of the buildings at less than 104° F. A design temperature limitation of 200° F is placed on piping in contact with or near concrete walls. Piping insulation and standoffs are utilized with that criteria to prevent excessive localized temperature effects on walls. For these reasons, the differential temperature

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factor T_O was not applicable to any of the subject walls.

The factor T_A is applied where design basis accident temperatures result in thermal loads due to the temperature gradient through walls such as Containment. The factor T_A is not applied to any masonry walls outside Containment.

The factor R is only applicable where the supporting structure must resist pipe break reaction forces, contained pressures, or flooding due to pipe rupture. The "Report on Analysis of Pipe System Breaks, Outside Containment, PGE-1004" identifies the locations where high energy pipe ruptures must be postulated and where these ruptures result in forces due to pipewhip, jet impingement, compartment pressurization, and flooding. The factor R will be applied to masonry walls, both inside and outside Containment, as appropriate.

The factors H_O and H_A are applied in cases where expansion of piping results in loads imparted to the structure. For purposes of design and analysis of piping and support systems at Trojan, the maximum thermal loadings from the greater of either accident$_{(A)}$ or normal maximum operating temperature$_{(O)}$ are used, and there has not been a differentiation between H_O and H_A. Thus, when the term H_O appears in load combinations, it is taken to be the limiting load from thermal expansion of piping under both normal operating and accident conditions.

The factor W, representing the wind loading, is in all cases less than the seismic inertia loading (E) for OBE. Thus, the load combination containing W is not governing.

The factor A is applicable only to the Intake Structure, since it is the only structure subject to a hydrostatic load due to an upstream dam failure. There are no masonry walls in the Intake Structure.

At the time when LER 79-15 was submitted, it was considered that the SSE loading combination provided the governing load combination for walls above elevation 45 ft. in the Control-Auxiliary-Fuel Building Complex. However, the continuing evaluation of other walls suggested that the loading condition which included the factored 0.15g OBE also could in some cases, result in the governing load condition. Considering the above, the masonry walls have been evaluated for load combinations which include either the 0.15g OBE or the 0.25g SSE as appropriate.

In the above loading combinations, E' is the SSE load, and E is the OBE load. In the course of the current Control Building proceedings, SSE spectra have been developed for areas in the Complex above ground level (el.45'). These response spectra were developed for the Complex both in its present condition and also as the Complex is proposed to be modified. In our present evaluations, the more conservative of these two spectra was applied in each instance.

SSE response spectra have not been developed for areas in the Plant other than the Complex above elevation 45. Therefore, for these other walls, the pipe restraint loads due to SSE are taken as 1.67 times those due to a 0.15g OBE (1.67 being the ratio of .25g to .15g). Comparisons where both OBE and SSE spectra were developed demonstrate very little variance between the two except in the rigid range (greater than 30 cps) where acceleration levels are insignificant compared to other forces. As a result, there can be as much as 67% margin inherent in the inertial load factor where E' is taken to equal 1.67 E.

A justification for using a factor of 1.5 times the UBC working stress design allowable for masonry structures is given in Attachment 2 of this Supplement.

Sample calculations illustrating the evaluations of the mortared double wythe block walls are provided in Attachment 1.

As of November 19, piping supports on single wythe and mortared double wythe block walls requiring corrective action are summarized below:

Systems	Through-Bolt	Modify	Total
Safety Injection	13	19	32
Residual Heat Removal	6	16	22
Containment Spray	1	6	7
Chemical & Volume Control	6	3	9
Boron Injection	1	5	6
Spent Fuel Pool Cooling	2	5	7
Component Cooling Water	-	2	2
Containment Chilled Water	-	1	1
Steam Generator Blowdown	-	1	1
TOTAL	29	58	87

The designs of the above supports have been completed and they are now being installed. Of the 29 supports where through-bolting will be employed, 9 have been completed. Eight of the 58 supports requiring modification to reduce wall loading have been completed. It is expected that the remaining through-bolting and modifications will be completed by December 1, 1979.

III. OTHER SUPPORT STRUCTURES

Other support structures in the plant are composite walls, concrete walls, concrete floor slabs and structural steel. These structures, which are more fully described in Attachment 3, are characteristically different from the walls initially identified as having a potential overstress condition (i.e. thin masonry walls with light reinforcement). These other types of structures have an inherent higher capacity to resist the relatively modest pipe loads in conjunction with their own seismic loads.

The nature of the overall piping system layout in the Plant and the reviews which have already been completed support our belief that further problems should not be expected. In Trojan, as in most other plants, the larger piping is usually located in the lower elevations of the Plant. Walls supporting the larger piping systems, particularly those with higher temperature ranges and those associated with the more significant safety systems (e.g., the RHRS), were among the first to be evaluated. Thus, a review of the Plant area and piping drawings shows that the walls that have already been reviewed encompass the majority of the larger diameter safety-related piping.

Therefore, we do not expect to find additional potential overstress conditions in these other structures. Nevertheless, to support our conclusion that the design of these other support structures adequately considered pipe support reaction forces, we have initiated the confirmatory review program described in Attachment 6.

ATTACHMENT 2

ADDITIONAL JUSTIFICATION FOR USE OF FACTOR 1.5 TIMES UBC WORKING STRESS ALLOWABLES

Design of masonry is normally done by the working stress design (WSD) method using unfactored loads. In accordance with UBC Section 2303, allowable stresses in the masonry may be increased by 1/3 when considering earthquake forces acting either alone or when combined with vertical loads.

Our evaluation of masonry walls has been done by using factored load equations. The following illustrates that such an evaluation using the factored loads and an allowable increase in stresses by 1/2 is more conservative than using unfactored loads and an increase of 1/3:

Factored load formula with 1.5 x UBC:

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$1.25\ (D + L + H_o + E)$

results in an equivalent capacity requirement of;

$$1.25\ \frac{D + L + H_o + E}{1.5}$$

$$= .833(D + L + H_o + E)$$

Unfactored load formula with 1.33 x UBC:

$1.0(D + L + H_o + E)$

results in an equivalent capacity requirement of:

$$1.0\ \frac{D + L + H_o + E}{1.33}$$

$$= .75\ (D + L + H_o + E)$$

Therefore, use of a 1/2 increase over UBC allowable stresses for normal operation is appropriate when factored loads are being considered.

ATTACHMENT 3

DESCRIPTION OF OTHER STRUCTURAL ELEMENTS

Reinforced Concrete Walls

The minimum size reinforced concrete wall in the Plant is 12". The reinforcing in each face of such walls is a #4 bar at 12" o.c. horizontal and a #3 bar at 12" o.c. vertical. Other reinforced concrete walls range in size up to 24". The maximum size wall in the spent fuel pool is 66". Table 1 shows a comparison of ultimate capacities (taken as 1.5 times working stress capacities) to the ultimate capacities of an 8" thick wythe.

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Composite Walls

20" and 24". These wall types have a double 8" wythe with concrete core. Each wythe is reinforced horizontally with a #6 bar at 2'-0" o.c. and vertically with a #5 bar at 2'-0" o.c.

27"-to-51". These wall types have a double 8" wythe with a concrete core. Generally, each wythe is reinforced vertically with a #6 bar at 2'-0" o.c. and horizontally with 2 #5 bars at 2'-0" o.c., (the only exception is that for walls 45" and larger, there are 2 #6 bars at 2'-0" o.c. horizontally). Thicker walls are correspondingly stronger.

Table 1 shows a comparison of ultimate capacities to the ultimate capacity of an 8" thick wythe (both taken as 1.5 times UBC working stress capacities).

Concrete Floor Slabs: As part of the Trojan design criteria, all floor slabs were designed for a 50#/ft.^{2} piping load over and above other area load criteria. (For large pipe which is supported by a floor, the original design of the floor accounted for each pipe support in addition to the above area load considerations).

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Steel Beams: In addition to supporting the above floors (including floor area pipe loads), each steel beam was designed for a 5 kip concentrated load.

TABLE 1

Comparison of Moment Capacities of Different Elements with Moment Capacity of an 8-inch Wythe Section, M_8

Reinforced Concrete Walls

Thickness (in.)	A_s		Moment Capacity M K-ft/ft	$\frac{M}{M_8}$
12	Horizontal	#4 @ 12 o.c.	5	5.68
	Vertical	#3 @ 12 o.c.	2.8	3.20
24	Horizontal	#6 @ 14 o.c.	20	23.0
	Vertical	#5 @ 17 o.c.	12	13.6
66		2 #11 @ 10 o.c.	538	611.0

Composite Concrete Walls

Thickness (in.)	A_s		Moment Capacity M K-ft/ft	$\frac{M}{M_8}$
20	Horizontal	6 @ 24 o.c.	8.4	9.5
	Vertical	5 @ 24 o.c.	5.8	6.6
24	Horizontal	6 @ 24 o.c.	10.5	11.9
	Vertical	5 @ 24 o.c.	7.2	8.2
27	Horizontal	2 #5 @ 24 o.c.	17.0	19.3
	Vertical	#6 @ 24 o.c.	12.1	14.0
51	Horizontal	2 #6 @ 24 o.c.	49.5	56.0
	Vertical	#6 @ 24 o.c.	25.0	28.0

ATTACHMENT 4

CRITERIA FOR THE EVALUATION OF STRUCTURAL MEMBERS TO RESIST PIPE LOADS

1 INTRODUCTION

The following criteria shall govern the evaluation of concrete slabs, mortared double wythe reinforced concrete masonry walls, composite reinforced masonry-concrete walls, concrete walls and steel structures to withstand pipe support loads.

2 GOVERNING DOCUMENT

Unless specifically stated otherw[illegible]e, the evaluation shall be in accordance with the Trojan Final Safety Analysis Report.

3 LOAD DEFINITIONS

All applicable loads given in Section 3.8.1.3.1 of the FSAR shall be considered in the evaluation.

4 LOAD COMBINATIONS

Load combinations shall be considered in the evaluation as follows:

4.1 During Normal Operation,

The most severe loading combination listed in FSAR Section 3.8.1.3.2 applies, except that the load combination

$U = 1.0D + 1.0L + 1.8E + 1.0\ T_o + 1.25\ H_o$ is inapplicable to walls, as will be explained in a subsequent supplement to LER 79-15.

4.2 During Accident and Safe Shutdown Earthquake,

The most severe loading combination listed in FSAR Section 3.8.1.3.3 applies.

4.3 Combination of In-plane Loading and Out-of-plane Loading in Walls

FSAR criteria state that the design of walls must include consideration of the loads resulting from the application on the structure of each horizontal component of earthquake combined separately with the vertical component. The pipe restraint loads due to seismic and thermal forces, however, have been determined as the envelope of the loadings generated by considering the seismic input as separate combinations of two cases: first, forces from one horizontal and the vertical combined by the SRSS method and second, combination of the forces from the other horizontal together with the vertical using the same method. Since the load envelope is used in the analysis, the resulting restraint loads can be treated as an approximation of loads from simultaneous action of the three earthquake components. For wall evaluations, the following two conditions will be considered:

4.3.1 Simultaneous action of pipe restraint loads and N-S and vertical components of earthquake considering both the in-plane and out-of-plane shear load, with the appropriate load factors.

4.3.2 Simultaneous action of pipe restraint loads and E-W and vertical components of earthquake considering the in-plane and out-of plane seismic inertia load on the wall, with the appropriate load factors.

5 ACCEPTANCE CRITERIA

5.1 Reinforced Concrete Walls and Slabs

The allowable stresses in these structures shall be in accordance with ACI 318-63 (FSAR Section 3.8.1.2).

5.2 Structural Steel

The allowable stresses shall be in accordance with AISC, Sixth Edition, 1967.

5.3 Reinforced Concrete Composite and Mortared Double Wythe Block Walls

5.3.1 For the purpose of this evaluation these walls have been considered in two categories:

- Walls modeled in the STARDYNE analysis of the Complex.

- Other walls in the Plant.

5.3.2 Walls modeled in the STARDYNE Analysis of the Complex

The capacities of these walls, which include composite walls and double wythe mortared reinforced concrete masonry walls, will be governed by the criteria justifying interim operation (see September 19, 1978 report, Section 4) for in-plane wall loads.

5.3.2.1 For mortared double wythe reinforced concrete masonry walls under the action of out-of-plane loads which include pipe restraint reaction:

a. For local pipe restraint tension reactions, the tensile bond stress capacity through the mortar between wythes shall be assumed to be zero (at present, tensile bond values have not been quantified).

b. For gross bending, where large pipe restraint tension reactions do not exist on the wall or where through-bolting is provided at the location of pipe restraint tension load reactions on the wall, the vertical shear transfer through the mortar between wythes (calculated as VQ/It) shall be limited to 1.5 times the UBC working stress allowable values for unreinforced masonry, UBC Table 24-B with special inspection. (1.5 x 12 = 18 psi)

c. For stress conditions local to the point of application of concentrated loads where reinforcement is not located in near proximity to the load, stresses shall be limited to 1.5 times the UBC working stress allowable values for unreinforced masonry, UBC Table 24-B with special inspection.

d. Allowable stresses for global wall action shall be limited to 1.5 times the UBC working stress allowable values for reinforced masonry, UBC Table 24-H with special inspection.

e. Stresses in reinforcing steel in the vicinity of the pipe restraint reactions shall be limited to 1.5 times the UBC working stress allowables specified in UBC Section 2417.

f. Allowable stresses for through-bolts shall be limited to 1.5 times UBC working stress values for bolts, UBC Table 24-G.

5.3.2.2 For composite reinforced masonry-concrete walls under the action of out-of-plane loads which include pipe restraint reactions:

a. Allowable tensile bond and shear stress between masonry and concrete core shall be limited to 50 psi (This subject is addressed in Attachment 5).

b. Allowable stresses for both local and global wall action shall be limited to 1.5 times the UBC work-stress allowable values for reinforced masonry, UBC Table 24-H with special inspection.

c. Stresses in reinforcing steel in the vicinity of the pipe restraint reactions shall be limited to 1.5 times the UBC working stress allowables specified in UBC Section 2417.

5.3.3 Other Walls

These walls, which include mortared double wythe reinforced concrete masonry walls and composite reinforced concrete masonry concrete walls, for in-plane wall loads will be governed by the UBC working stress allowable values for reinforced masonry per UBC table 24-H, with special inspection, multiplied by 1.5.

For out-of-plane wall loads, stresses shall be limited to the values specified in Section 5.3.2.1 and 5.3.2.2 above.

ATTACHMENT 6

CONFIRMATORY REVIEW PROGRAM-OTHER STRUCTURES

1. Composite Walls

All composite walls in the Plant will be surveyed to identify those supporting safety-related piping. An evaluation of the walls so identified will be performed. This evaluation will be in accordance with the criteria specified in Attachment 4 and will consider loads on the wall from all safety and nonsafety-related piping, equipment and cable trays, and from the wall's own inertial loads. Loads imparted by small piping (2" diameter and under) which do not produce thermal loads, will not be included in the evaluation because the magnitude of the loads generated by such piping is negligible. Design bases for seismic evaluation of small piping by maximum span criteria have shown that loads will be generally less than 100 pounds. The minimum size composite wall is 20" thick and small piping loads have an insignificant effect on the wall's reserve capacity. Equipment loads will not be included in the evaluation if the load is less than 100 pounds.

2. Concrete Walls, Floor Slabs and Structural Steel:

For those areas of the plant where existing documentation is not complete, a survey will be conducted by licensed Civil Engineers to identify those concrete walls, floor slabs and structural steel members supporting safety-related piping which could be highly loaded relative to their capacities. Based on the results of this survey, those elements which appear to be most heavily loaded relative to their capacity will be evaluated in accordance with the criteria specified in Attachment 4.